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SPECIFICATION NO. 54-A-1027-A

DEVELOPMENT SPECIFICATION
FOR
RS-11A PORTABLE RADIO STATION

9 March 1954

1. GENERAL

1.1. Purpose Of This Specification

This specification shall stipulate the performance requirements of the RS-11A communications equipment and present the electrical and mechanical design characteristics that shall guide the development and production of prototype models of such equipment.

1.2. System Description

The RS-11A shall be a lightweight, miniaturized, CW communications system consisting of a transmitter and receiver with a frequency range of from 3 to 12 megacycles. The transmitter and receiver shall be separate units. In addition to CW reception, the receiver shall be capable of MCW and voice reception. The RS-11A shall be powered by, and compatible with, batteries, type BA-1264/U or exact equivalent. A canvas carrying case shall be provided to permit ease of transport of the equipment and batteries.

1.3. Nomenclature

The three units of equipment comprising the RS-11A shall be identified as the RT-11A, transmitter; the RR-11A, receiver; and the CC-11, carrying case.

2. QUALITY OF DESIGN AND FABRICATION

The electrical and mechanical design of the RS-11A shall be directed towards the development of a quality product reflecting the highest possible degree of equipment reliability when exposed to the normally rough handling encountered in field usage.

2.1. JAN Specifications

The Contractor shall utilize components, materials and fabrication procedures meeting JAN Specifications of the issue in effect on the date of initiation of the contract.

2.1.1. JAN Specification Waiver

In any instance where the Contractor may deem it necessary to utilize other than components, materials and fabrication procedures meeting JAN Specifications, specific waivers may be authorized by the Government, but only after review by Government engineers and prior to the submission of any prototype models.

2.2. Fungus Treatment and Moisture Proofing

Fungus treatment and moisture proofing of all components, wiring, terminal boards, etc., shall be in accordance with JAN Specifications JAN-T-152 and JAN-C-173, Class 1.

2.3. Operating Temperature

2.3.1. Mechanical Malfunctioning

The mechanical design considerations of the RS-11A shall be such as to preclude equipment malfunctioning when exposed to operating temperatures of from plus 40 degrees C. to minus 40 degrees C.

2.3.2. Electrical Malfunctioning

The RS-11A shall meet each and every electronic requirement contained in this Specification when exposed to operating temperatures of plus 40 degrees C. to a low operating temperature as determined under the provisions of Section 2.3.2.1., below.

2.3.2.1. Low Operating Temperature Test - Inasmuch as the low operating temperature for this equipment will be determined, in part, by the current capacity of the mercury batteries when exposed to low temperatures, the Contractor shall determine by test the lowest operating temperature at which the equipment shall be capable of possessing functional electrical characteristics at the conclusion of 24-hour operation under duty cycle tests.

2.4. Storage Temperature

The design of the equipment shall be such as to permit storage from plus 60 degrees C. to minus 60 degrees C. without damage or impairment of operation.

2.5. VACUUM TUBES

2.5.1. General Considerations

In general the design of the RS-11A shall be such as to insure that vacuum tube operation shall be within the requirements of the manufacturer's recommended limits, or JAN Specifications, if applicable. However, should it become desirable to incorporate tubes that shall function outside such limits, it shall be contingent upon the Contractor to prove by adequate tests that continued operation outside such limits shall not introduce unreliability, instability, or other forms of deleterious operation.

2.5.2. Vacuum Tube Investigation

Inasmuch as the trend of vacuum tube manufacturers is directed towards higher working voltages for miniature and subminiature vacuum tubes and in consideration of the intent of Section 2.5.1., above, the Contractor shall investigate new tube designs to permit maximum efficient use of the voltages available for this equipment.

2.5.3. Vacuum Tube Replacement

It shall be mandatory that vacuum tube replacement for the RS-11A shall not require individual tube selection and further that the specified electrical characteristics shall be maintained with vacuum tubes that represent the extremes of their characteristics within the confines of JAN Specifications for high and low electron emission with the battery voltages available. Section 2.5.1. shall apply.

3. JAN BATTERY TYPE BA-1264/U

Battery type BA-1264/U (MIL-B-18/129 dated 1 July 1953) is composed of mercury cells with a nominal "A" supply of 1.3 volts and a capacity of 25,600 milliamperes-hours with an end point of 1.05 volts. The "B" supply is a nominal 14.3 volts with a capacity of 630 milliamperes-hours and an end-point of 85 volts. The cases of these batteries are common to "A" minus and must be insulated from each other should a series filamentary supply be required.

4. CIRCUITRY AND DESIGN CHARACTERISTICS

The specific circuitry to be employed in the development and production of RS-11A prototype models shall be determined by the engineering ingenuity of the Contractor and shall meet all requirements for (1) battery type BA-1264/U compatibility and (2) the electronic operational characteristics required of the equipment by the Government. A minimum amount of general circuitry is proposed to restrict the number of operating controls and to permit the incorporation of other special features desired.

4.1. Operating Modes

The RS-11A shall be capable of the following modes of operation:

4.1.1. Transmitter Operation

Independent operation of the transmitter with two batteries type BA-1264/U, series connected.

4.1.2. Receiver Operation

Independent operation of the receiver with a single battery type BA-1264/U.

4.1.3. Simplex Operation

Simplex operation of the transmitter and receiver with two batteries type BA-1264/U series connected for transmitter operation, the batteries being center-tapped for operation of the receiver. A combination power-antenna switch shall be necessary for this mode of operation and shall be a component of the transmitter.

4.1.4. Duplex Operation

Duplex operation of the transmitter and receiver utilizing two batteries type BA-1264/U, series connected, for the transmitter and a single battery type BA-1264/U for the receiver. Separate receiving and transmitting antenna terminals shall be necessary for this mode of operation.

4.2. RT-11A Transmitter

The RT-11A shall be a crystal controlled radio transmitter covering the frequency range of from 3 to 12 megacycles. The unit shall be battery powered and capable of being keyed at 30 words-per-minute with a nominal power output of three watts with fresh batteries.

4.2.1. Crystal Control

Crystal fundamental mode of operation shall be employed throughout the prescribed frequency range. Military Standard 91377 utilizing Armed Services Crystal Unit CR-18/U and holder HC-6/U operates on fundamentals from 800 kilocycles to 15 megacycles and is satisfactory. Attention is invited to MIL-C-3092A dated 19 November 1952. The crystal shall plug into the case externally.

4.2.2. Oscillator Circuitry

Oscillator circuitry shall function without doubling. The oscillator shall exhibit no evidence of crystal overmode oscillation. The oscillator input capacity for crystal correlation shall be between 26 muf. and 32 muf.

4.2.3. Power Amplifier and Tank Circuitry

Two batteries type BA-1264/U series connected for a plate potential of 286 volts (no load) may be employed in the design of the transmitter power amplifier.

4.2.3.1. Resonance Indicator - A neon bulb inserted across the tank circuit shall serve as a resonance indicator.

4.2.4. Antenna Coupling

The antenna impedance for the RT-11A will vary between 75 and 1200 ohms with a phase angle of plus or minus 45 degrees. Consequently the transmitter shall possess a system of antenna loading that will permit maximum power transfer over the frequency range.

4.2.4.1. Antenna Loading Indicator - A small incandescent bulb in series with the antenna terminal shall serve as the antenna current indicator. The antenna current indicator shall be shunted by a suitable switch.

4.2.5. Side Tone Oscillator

A special feature of the transmitter shall be a side-tone oscillator to permit monitoring of the operator's keying. A neon type relaxation oscillator is satisfactory.

4.2.6. Transmitting Hand Key

The transmitting hand key shall be an integral part of the RT-11A. The hand key as envisioned shall be of the spring loaded button type designed to actuate a microswitch and shall be acoustically noise free. The button, a miniaturized version of a standard hand key knob, to be mounted in a recessed panel surface area.

4.2.7. Alternate Keying Provision

The design of the keying circuitry shall include provisions for keying the transmitter from an external source. The input for such keying provisions shall be miniaturized pin jacks.

4.2.8. Keying Waveform

The transmitter shall be capable of being keyed at speeds up to 30 words per minute. The envelope of the keyed wave shall possess rounded corners on the leading and trailing edges and shall have no sharp peaks or abrupt transients.

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Power Output

The power output of the transmitter shall be 3 watts, nominal, and shall not fall below 1.5 watts, nominal, at the conclusion of the 24-hour duty cycle of Section 4.3.

4.2.10. Radiated Interference Elimination

Radiated interference elimination within the 15 kilocycle - 220 megacycle frequency spectrum shall be a prime consideration in the design of the RR-11A transmitter. Filtering and shielding, unusual for this type of equipment, may be incorporated as required to further this end.

4.2.10.1. Key Clicks - The RR-11A shall be devoid of key click radiation.

4.2.10.2. Harmonic Radiation - Second harmonic radiation shall be down a minimum of 25 decibels, third harmonic radiation shall be down a minimum of 30 decibels and fourth and higher order harmonics shall be down a minimum of 50 decibels from the fundamental throughout the frequency range of 12 to 54 megacycles.

4.2.10.3. Low Frequency and T.V.I. - All radiation other than the harmonics of Section 4.2.10.2., above, shall be down 80 decibels below the fundamental over a frequency span of from 15 kilocycles to 220 megacycles.

4.2.10.4. Spurious Radiation - No spurious radiation, other than the harmonics enumerated in Section 4.2.10.2. and 4.2.10.3. above shall be generated. The generation of any R. F. power with the crystal removed from its socket shall not be permitted.

4.3 RR-11A Receiver

The RR-11A receiver shall be a lightweight, miniaturized radio receiver capable of CW, MCW, and voice reception over the frequency range of 3 to 12 megacycles. Circuitry of the receiver shall be such as to meet all requirements for dial calibration accuracy, sensitivity, selectivity, image rejection, etc., as required by this Specification when tested in accordance with test specifications. The RR-11A shall be compatible with, and powered by a single battery type BA-120/U. The electrical characteristics contained herein shall be those obtainable with fresh batteries, and at the operating temperature extremes.

4.3.1. Receiver Frequency Calibration

The realization of the dial calibration accuracy and dial resettability required, and the development of a feasible method of calibrating this unit of equipment when manufactured in production quantities shall constitute a specific aim of this development.

- 4.3.1.1. Dial Calibration Accuracy - The calibration accuracy of the tuning dial shall be within 0.1% throughout the tuning range.
- 4.3.1.2. Dial Resetability - The accuracy of resetability shall be within 0.01% when approached from either the high or the low end of the tuning range.
- 4.3.1.3. Dial Markings - Numbered dial markings on the main tuning control shall be provided at 50 kilocycle intervals up to 6 megacycles of frequency coverage and at 100 kilocycle intervals thereafter. Intermediate dial marks shall be provided in a number compatible with dial length and frequency spread.
- 4.3.1.3.1. The Contractor shall investigate the feasibility of providing luminous dial markings to permit receiver tuning in complete darkness.
- 4.3.1.4. Dial Scale - The dial scale length shall be made as great as possible consistent with dial calibration accuracy and resetability.
- 4.3.2. Raw Noise
- Raw noise shall not exceed 0.02 milliwatts, A.M. or C.W. when tested in accordance with the equipment Test Specifications.
- 4.3.3. Sensitivity
- The nominal C.W. sensitivity shall be such that a 5 microvolt signal input will produce an output of 0.5 milliwatts, signal plus noise, across 4,000 ohms. The A.M. sensitivity shall be such that a 15 microvolt signal input modulated 30% with a 1,000 c.p.s. tone will provide an output of 0.5 milliwatts, signal plus noise, across 4,000 ohms.
- 4.3.4. Audio Output
- The audio output circuitry shall be designed to deliver maximum power to a 4,000 ohm load. The output for this equipment shall consist of two 2,000 ohm Telux earpieces (magnetic type), or equivalent, series connected.
- 4.3.5. Audio Response
- The audio response shall be essentially flat and not fall below 3 decibels over the range of 150 to 2500 c.p.s.
- 4.3.6. Antenna Coupling
- The antenna impedance for this equipment shall vary between 70 and 3,000 ohms.

4.3.7. Oscillator Frequency Pulling

Oscillator pulling with control of gain or with variation in signal strength shall be held to a minimum. Maximum oscillator frequency change with variation in gain shall not exceed 100 cycles when the gain control is varied between minimum and maximum. Oscillator frequency change with variation in input signal shall not shift more than 100 cycles between signal input levels 5 microvolts and 200,000 microvolts.

4.3.8. Oscillator Drift

After a five-minute warm-up, the rate of change of frequency of the high frequency oscillator due to any cause shall be less than .0004 percent per minute.

4.3.9. I.F. and Image Rejection

In the event that superheterodyne circuitry is employed in the design of this equipment the I.F. rejection ratio shall exceed 60 decibels and the image rejection ratio shall exceed 50 decibels over the frequency range.

4.3.10. Over-all Selectivity

The over-all selectivity shall approximate the following:

Response (Decibels)	Bandwidth (Kilocycles)
- 3	5.0
- 6	5.4
- 10	6.2
- 20	7.8
- 40	11.2
- 60	16.0

4.3.11. Radiation Interference Elimination

Radiation interference elimination shall be a prime consideration in the design of the RS-11A receiver. Shielding, unusual for this type of miniaturized equipment may be incorporated as required to further this end.

4.4. RS-11A Duty Cycle

The operating duty cycle for equipment-battery compatibility shall be such as to provide 24 hours of operation with a duty cycle consisting of one-half hour of receiver operation followed by fifteen minutes of transmitter operation on a repetitive basis for a total lapsed time of 24 hours.

4.4.1. Operating mode

Duty cycle tests shall be conducted with one set of two batteries type BA-1264/U for simplex operation as described under the requirements of Section 4.1.3.

4.4.2. Duty Cycle Test Operation

The receiver shall deliver full rated power output and the transmitter shall be keyed at a rate of 12 dot cycles per second during duty cycle tests.

4.4.3. Duty Cycle Test Operating Characteristics

The equipment shall be capable of maintaining functional operating characteristics throughout the 24 hours of cycling over the frequency range of the equipment.

4.5. RS-11A Test Specification

Test of the RS-11A operational characteristics shall be conducted in accordance with RS-11A Test Specifications which shall be a part of the RS-11A Development Specification.

5. RS-11A PACKAGING

The intended diversified operational compatibility of the units shall require dual packaging techniques. It is intended that quick operational assembly of the equipment and batteries shall be possible with a building block arrangement devoid of any cabling. A further requirement exists for power cabling such as will permit equipment operation while the batteries remain in the CC-11 carrying case. Several modes of operation shall be required of the RS-11A when packaged as above.

5.1. Adaptors

Special adaptors shall be provided to permit physical connection of the batteries to the equipment cases and cables. Data on the terminal socket of BA-1264/U is contained in MIL-B-18/129 and data on "National Special" Specifications is contained in a "1950 Supplement to Screw-Thread Standards for Federal Services 1944" published by the National Bureau of Standards.

5.1.1. Alternate Power Connector

A special male connector shall be provided to permit operation with other than batteries type BA-1264/U. Such connectors shall plug into the equipment and terminate with four wire leads. The leads shall be suitable color coded and tagged.

5.2. Adaptors and Cables

Adaptors and cabling shall be such as to provide the modes of operation described in Section 4.1.

6. MECHANICAL DESIGN CHARACTERISTICS

6.1. CC-11 Carrying Case

A canvas carrying case shall be provided as a component of the RS-11A to permit ease in transport of the equipment. Suitable partitions shall be provided for the RT-11A, the RR-11A, three batteries type BA-1264/U and normal accessories. The battery partitions shall be such as to provide insulation between the battery cases.

6.2. RT-11A and RR-11A

6.2.1. Weight

The combined weight of the RT-11A and the RR-11A shall not exceed 4 pounds.

6.2.2. Dimensions

The maximum dimensions of either unit of the RS-11A shall not exceed the dimensions of one battery type BA-1264/U. The approximate dimensions of this battery are 3 1/2" X 2 1/3" X 6 1/4". The receiver and transmitter need not possess identical dimensions, the foremost consideration being reduced physical size.

6.2.3. Unit Case Construction

The contractor shall determine the suitability of magnesium versus aluminum for fabrication of the equipment cases for the RR-11A and RT-11A. As a third alternative, the Contractor may recommend a particular plastic for fabrication of the equipment cases.

6.2.3.1. Case Cover - The Contractor shall investigate the feasibility of providing a watertight hinged cover or partial cover that shall serve to cover the operating controls and adaptor recepticals of the equipment.

6.2.3.2. Case Corners - All corners of the equipment cases shall be rounded to a 1/4" radius.